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WARM DENSE MATTER EXPERIMENTS WITH INTENSE HEAVY ION BEAMS*

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As a technique for heating volumetric samples of matter to high energy density, intense beams of heavy ions are capable of delivering precise and uniform beam energy deposition dE/dx , in a relatively large sample size, and with the ability to heat any solid-phase target material. In this talk we will present initial results from heavy ion heating warm dense matter (WDM) experiments at the Neutralized Drift Compression Experiment (NDCX) at Lawrence Berkeley National Laboratory (LBNL). The WDM conditions are achieved by combined longitudinal and transverse space-charge neutralized drift compression of the ion beam to provide a hot spot on the target with a beam spot size of about 1 mm, and compressed pulse length about 2 ns. Initial experiments use a 0.3 MeV, 30-mA K^+ beam (below the Bragg peak) from the NDCX-I accelerator to heat foil targets such as Au, Al, Si and C. The NDCX beam contains an uncompressed pulse up to $>10 \mu s$ of beam flux $\geq 500 \text{ kW/cm}^2$, and a compressed pulse of flux $> 5 \text{ MW/cm}^2$. Future plans include construction of the NDCX-II accelerator, which is designed to heat targets at the Bragg peak using a 3-4 MeV lithium ion beam.

We have developed a WDM target chamber and a suite of target diagnostics including a fast multi-channel optical pyrometer, optical streak camera, VISAR, and high-speed gated cameras. Initial WDM experiments heat targets by both the compressed and uncompressed parts of the NDCX-I beam, and explore measurement of temperature, droplet formation and other target parameters. Continued improvements in beam tuning, bunch compression, and other upgrades are expected to yield higher temperature and pressure in the WDM targets. Future experiments are planned in areas such as dense electronegative targets, porous targets and two-phase equation of state.

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